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(54) **CHEMICAL INJECTION CHECK VALVE INCORPORATED INTO A TUBING RETRIEVABLE SAFETY VALVE**

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E21B 47/10 (2006.01)
E21B 34/06 (2006.01)
E21B 41/02 (2006.01)

(52) **U.S. Cl.** **166/250.08**; 166/312; 166/324

(58) **Field of Classification Search** ..... 137/70, 137/512; 166/250.08, 300, 311, 312, 324, 166/332.1, 337, 336; 73/40.5 R, 49.5
See application file for complete search history.

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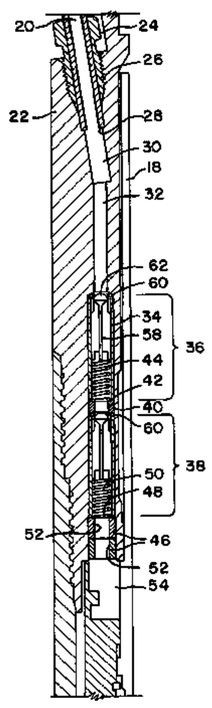
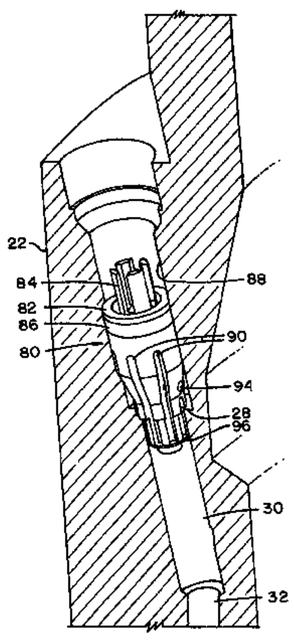
(57) **ABSTRACT**

Disclosed herein is a safety valve with a chemical injection configuration. The device includes a hydraulic fluid pressure operated piston at the housing. The device further includes a flow tube in operable communication with the piston and a chemical injection configuration disposed within the housing. Further disclosed herein is a method of maintaining the operation of a safety valve by injecting chemical fluid through a configuration within the safety valve.

Still further disclosed herein is check valve. The check valve includes a seal, a dart having a closed head and sealable against the seal, one or more flutes on the dart, and a spring applying a biasing force to the dart to a sealing position, that force being overcomeable by a fluid pressure acting in a direction opposing the spring force.

10 Claims, 5 Drawing Sheets





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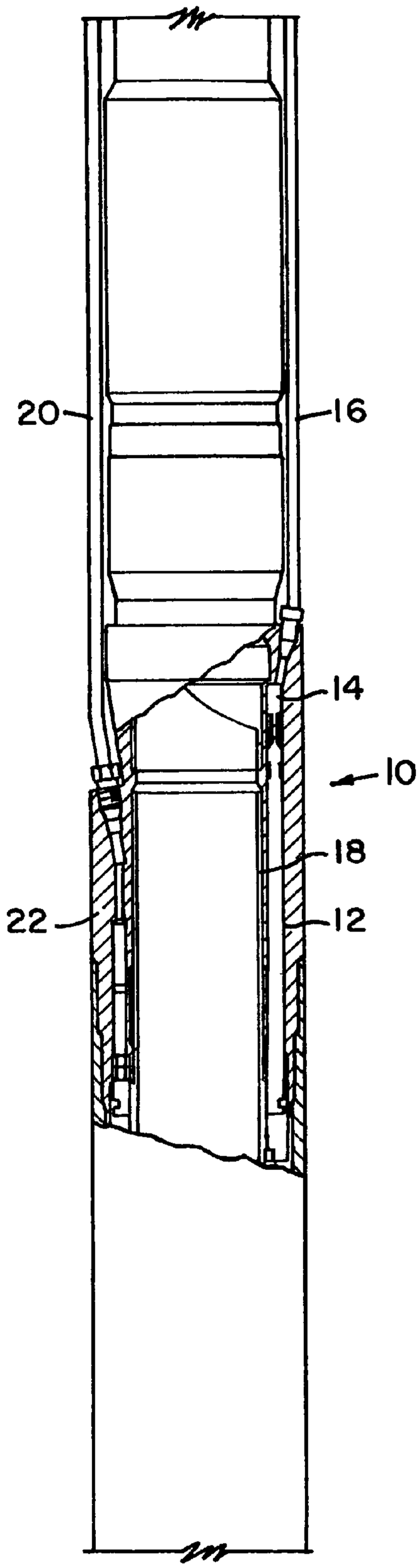

FIG. 1

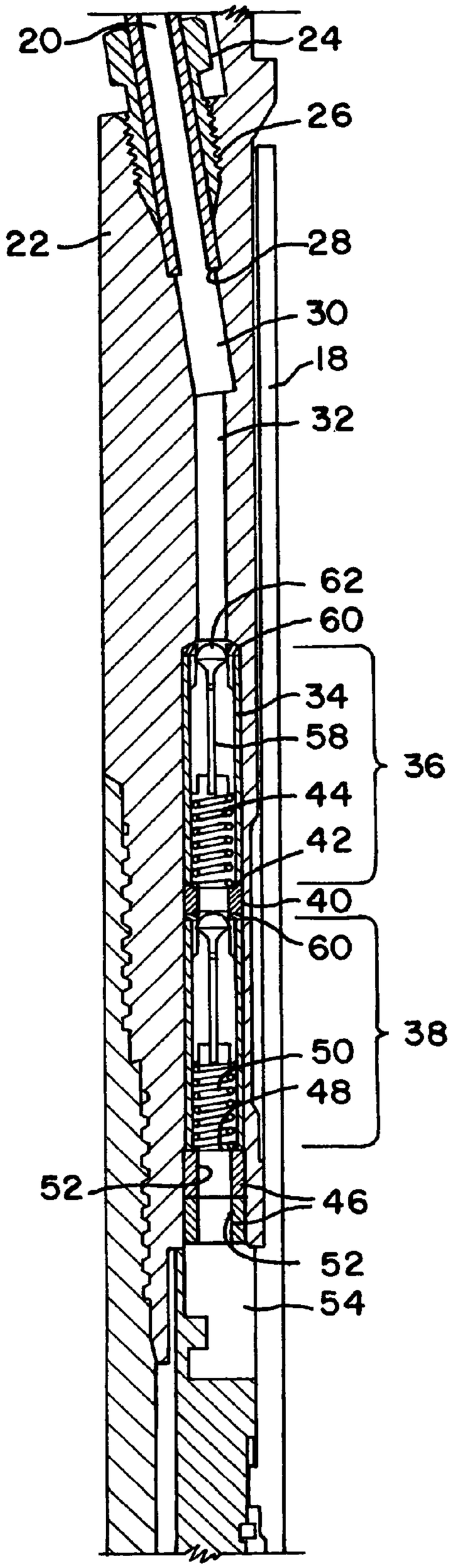

FIG. 2

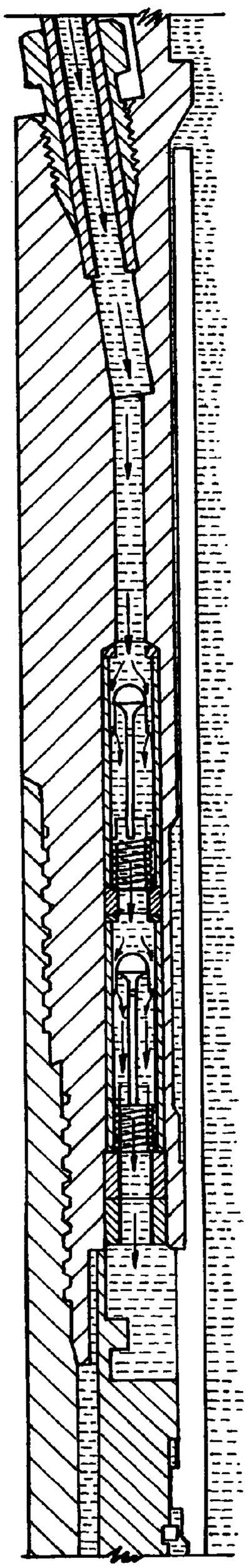

FIG. 3

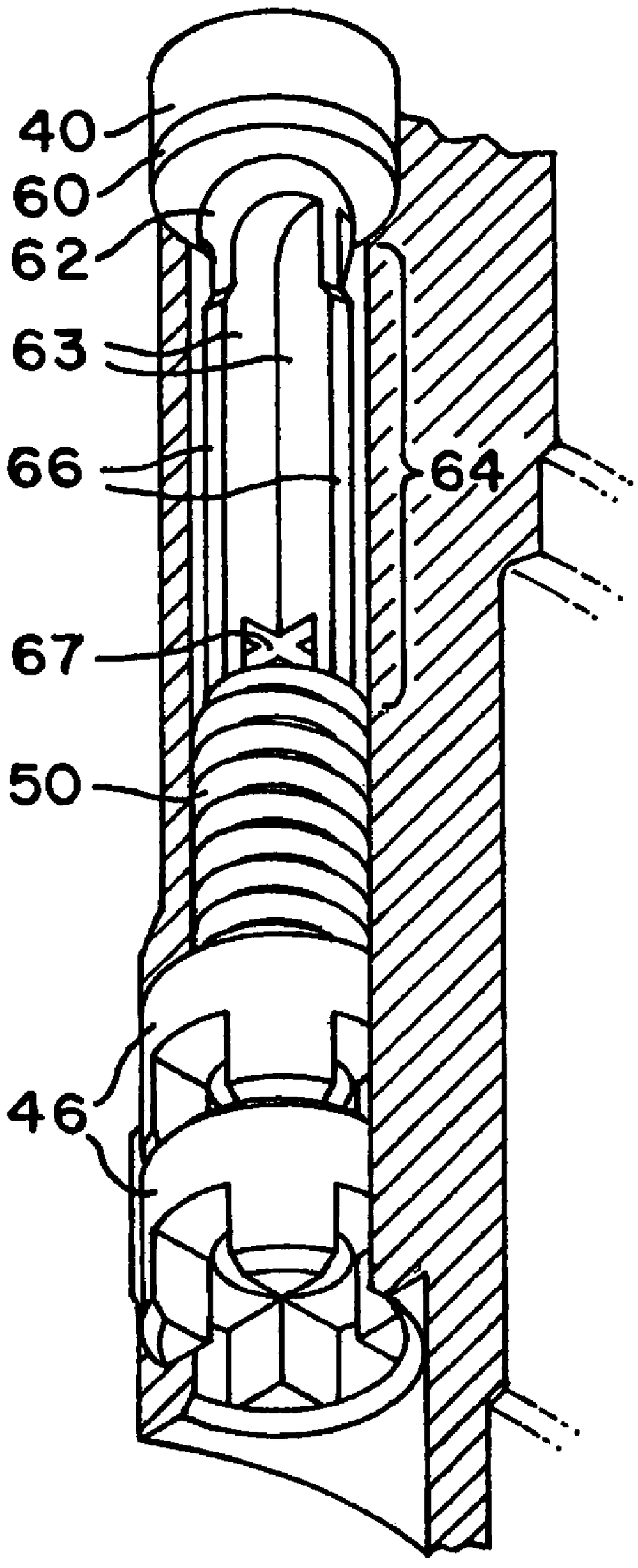

FIG. 4

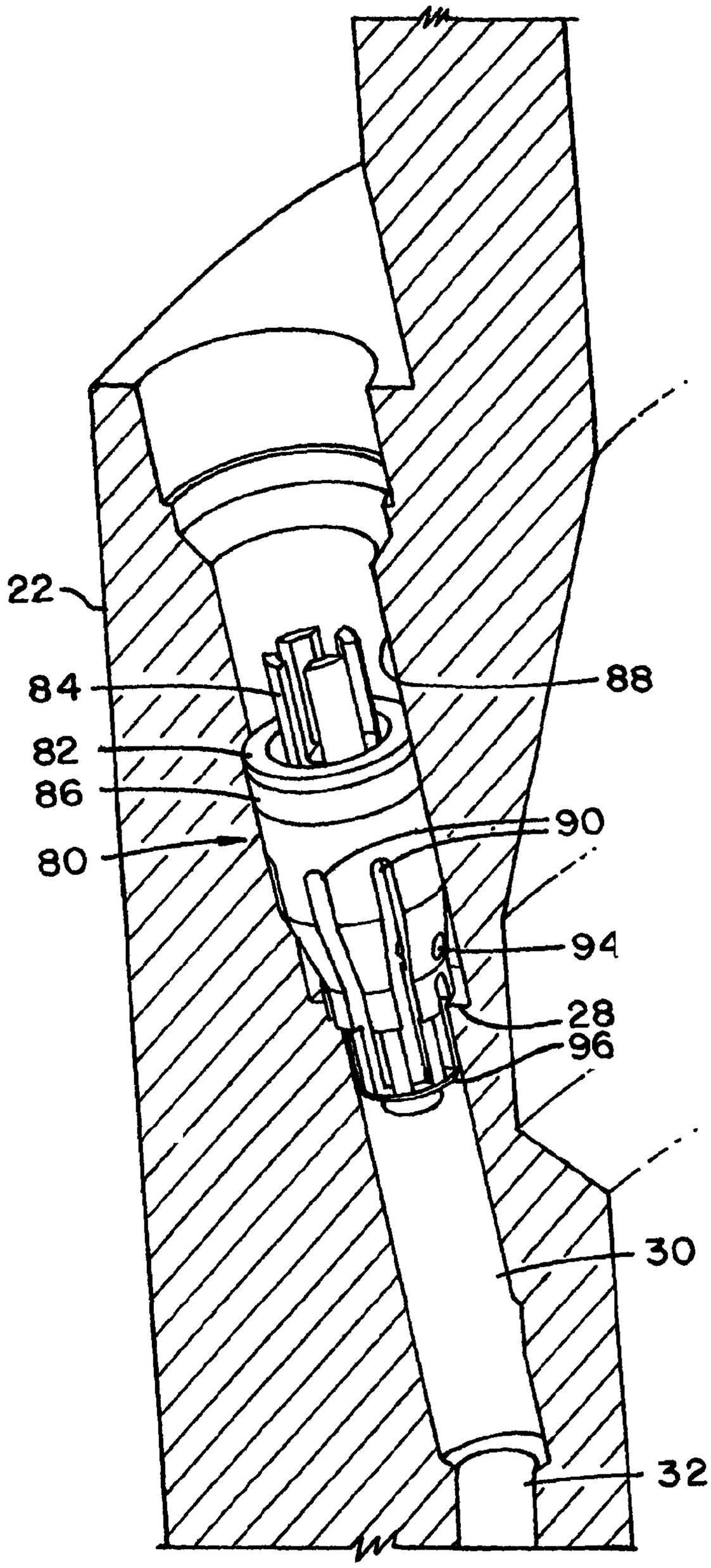

FIG. 5

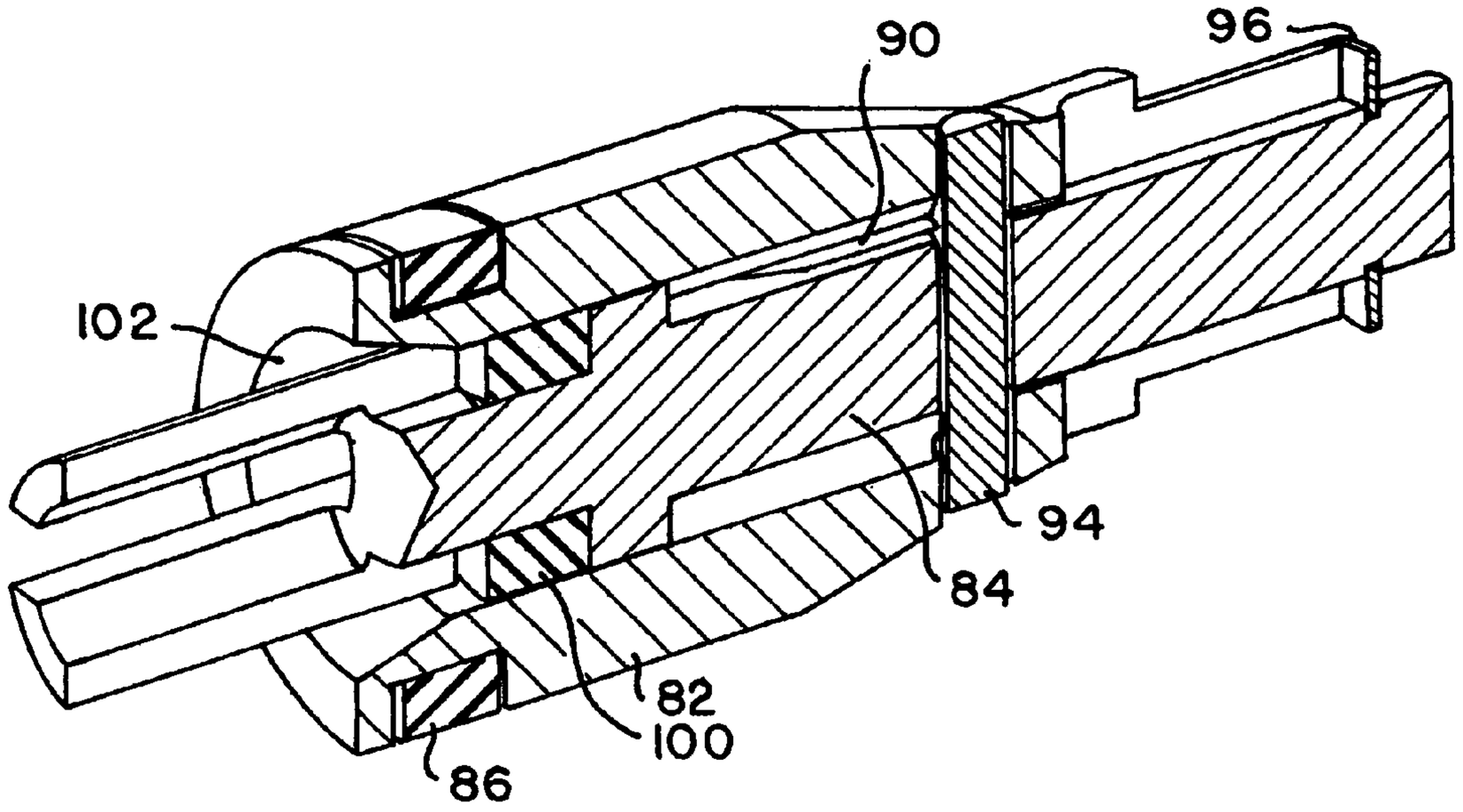

FIG. 6

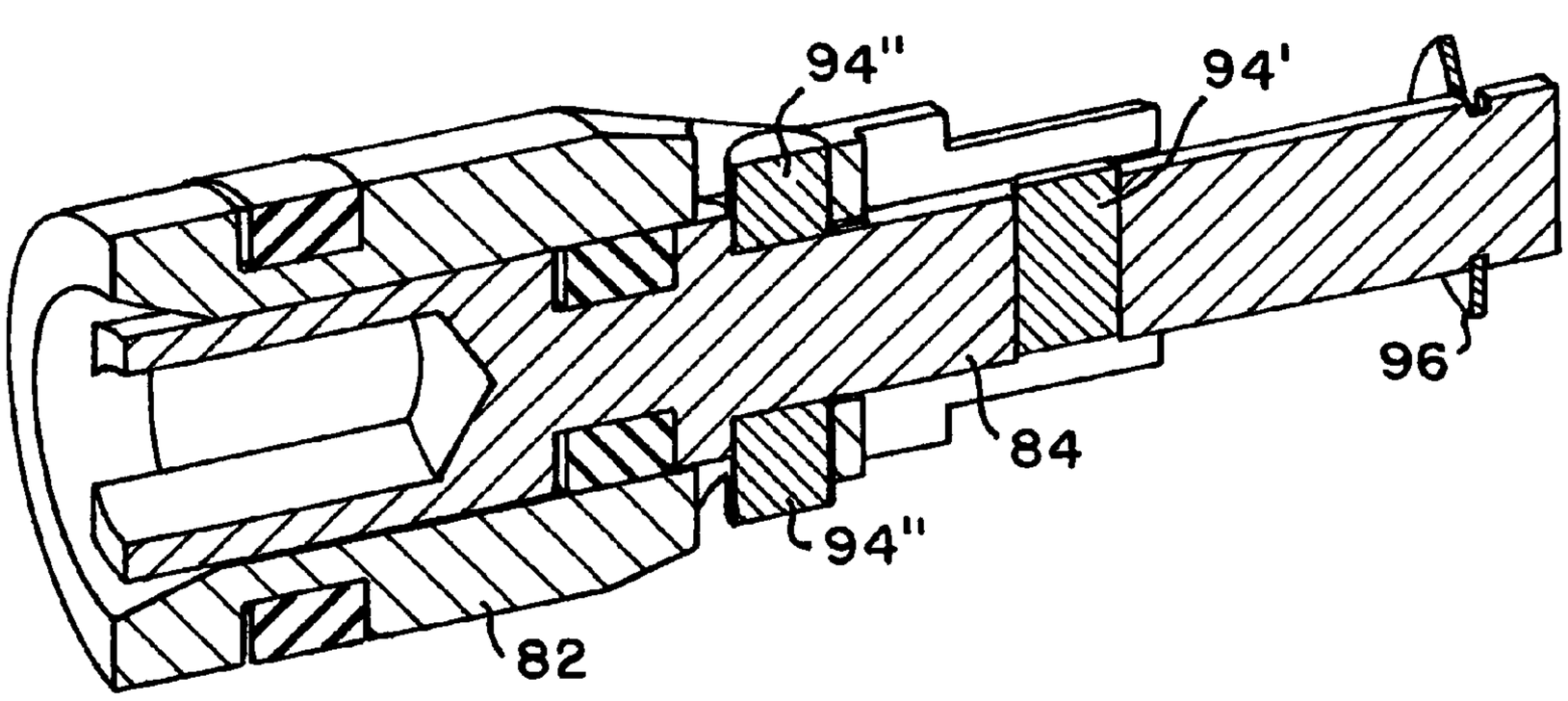

FIG. 7

CHEMICAL INJECTION CHECK VALVE INCORPORATED INTO A TUBING RETRIEVABLE SAFETY VALVE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of an earlier filing date from U.S. Ser. No. 60/514,868 filed Oct. 27, 2003, the entire contents of which is incorporated herein by reference.

BACKGROUND

Chemical injection is often used in the downhole oilfield industry in conjunction with safety valves such as tubing retrievable safety valves because a common and relentless problem is a buildup of scale, hydrates, paraffin and other undesirable solids on downhole structures. Any one or combination of these solids collecting in a safety valve, i.e., on or around a flapper, on the torsion spring, on the flow tube, the power spring, etc., can hamper the ability of the safety valve to function at optimum. Chemicals, which are selected depending upon the chemistry of the wellbore and therefore the chemistry of the solids presenting problems, can be injected down into the downhole environment to dissolve such solids. In general, with respect to tubing retrievable and other safety valves in a traditionally accepted configuration, included at an uphole end thereof via common connections such as a premium thread, a secondary chemical injection device which is connected to a surface location for application of chemicals. Chemicals are injected from the location of the injection valve above the safety valve and are calculated to migrate to the areas of the safety valve. Clearly density, turbulence, obstruction and other issues may hamper the movement of the chemical to the safety valve. In addition the chemical often does not reach inner workings of the safety valve not directly exposed to the flow area thereof.

Chemical injection devices as described are expensive, cause spacing out issues and connection issues. In view of the ever increasing need for efficiency and cost effectiveness, the applicants herein have developed a new system which is more efficient, more effective, of lower cost, and beneficial to the art.

SUMMARY

Disclosed herein is a safety valve with a chemical injection configuration. The device includes a hydraulic fluid pressure operated piston at the housing. The device further includes a flow tube in operable communication with the piston and a chemical injection configuration disposed within the housing.

Further disclosed herein is a method of maintaining the operation of a safety valve by injecting chemical fluid through a configuration within the safety valve.

Still further disclosed herein is a check valve. The check valve includes a seal, a dart having a closed head and sealable against the seal, one or more flutes on the dart, and a spring applying a biasing force to the dart to a sealing position, that force being overcomeable by a fluid pressure acting in a direction opposing the spring force.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings wherein like elements are numbered alike in the several Figures:

FIG. **1** is a partially cut-away view of a tubing retrievable safety valve having a chemical injection system provided therein;

FIG. **2** is a cross-section expanded view of the left side of the cut-away portion in FIG. **1**;

FIG. **3** is the same structure as that of FIG. **2** both in a position related to the injection of chemical to the safety valve;

FIG. **4** is a perspective view of a check valve in accordance with this disclosure;

FIG. **5** is a perspective view of a pressure test assembly installed in a tubing retrievable safety valve;

FIG. **6** is a cross-sectional view of the pressure test assembly before retainer override; and

FIG. **7** is a cross-sectional view of the pressure test assembly after retainer override.

DETAILED DESCRIPTION

Referring to FIG. **1**, a break-away view of a tubing retrievable safety valve (TRSV), modified according to the disclosure is illustrated. The safety valve is generally indicated at **10**. One of ordinary skill in the art should recognize piston **12**, piston chamber **14**, control line **16** and flow tube **18** as common components of a TRSV. A TRSV such as Baker Oil Tools part number H826103110. The balance of the components of the TRSV are considered known to the art and not in need of discussion or illustration. In accordance with the disclosure hereof TRSV body **22** is provided with a chemical injection configuration directly in the housing thereof. A greater disclosure of the configuration is made hereunder. Also illustrated in FIG. **1** is a secondary line **20** which is in fact a chemical injection line leading to a remote location, which may be a surface location or other downhole location, having access to a supply of chemical(s) for injection. As will be understood by one of ordinary skill in the art, different chemicals are utilized at different times for different reasons, each of which can be sent down the chemical injection line **20** as discussed further herein.

Referring now to FIG. **2**, chemical injection line **20** is connected to body **22** by conventional means utilizing a control line nut **24** threaded into a tap section **26** in TRSV body **22**. The control line **20** extends a short distance as illustrated below nut **24** to bottom on shoulder **28** of a smaller dimension conduit **30** leading to a channel **32**. The interconnection between section **30** and **32** need merely provide for sufficient volume of chemical injected fluid to be acceptable. The channel **32** leads to a larger dimension channel **34** which is configured to receive two check valves **36** and **38** to prevent wellbore fluids from moving up the chemical control line. Between check valve **36** and **38** is spacer **40**, which allows the check valves to operate properly since it provides a surface **42** against which the spring **44** of the first check valve **36** may bear and in addition provides space between surface **42** and the top of check valve **38** to avoid inhibition of fluid flow. The check valves are held in position by two nuts (in one embodiment) **46**, one of which provides a seat **48** for spring **50** and the second of which simply locks the first nut **46**. Both of the lock nuts are center drilled to create a tube **52** such that chemical injection fluid may pass therethrough and into chamber **54** whereafter the fluid will bleed in all directions around components of the safety valve. It is important to note that there are no seals between the housing **22**, the flow tube **18**, the power spring which is not shown herein but which is known to one of ordinary skill in the art, and other components of this device. One of the great advantages of the configuration as set forth herein is that the chemical injection

fluid must flow through these parts in order to reach the inside dimension of the wellbore making it much more likely that the chemical injected fluid is going to reach all of the places that might otherwise have hydrate and other solid buildup. This is a significant advantage since it requires less chemical to be injected and will take less time for the chemical to reverse the solids deposition process that affected performance of the safety valve and gave rise to the need for treatment.

It is important to point out that during the creation of this device the inventors concluded that check valves common in chemical injection configurations would not function properly in this device. This is because all the chemical injection valves are created to be utilized in a larger bore which allows them to have a central flow channel. This is not possible in this case due to the restricted diameter which itself is due to the thickness of the housing **22**. In order to make the device function as intended, the inventors hereof were required to design a new check valve that would allow sufficient flow to achieve the desired result while still functioning within a narrower conduit than prior art check valves.

FIG. **2** provides an illustration of a cross-section of the valve itself and FIG. **4** should be viewed contemporaneously to provide perspective.

The check valve itself (see FIG. **4**) comprises a seal **60** which in one embodiment is a PEEK seal ring which will interact with a dart head **62**, which is in this embodiment a semi-spherical configuration. It is contemplated however that different shapes such as oval might be utilized. In the presently discussed embodiment, the semi-spherical head **62** is followed by one or more flow flutes **63** in a body portion **64**. The machining or flutes, in one embodiment, is in 90 degree increments leaving a small amount of material identified herein as rib **66** between each of the flutes. It will be appreciated that a cross-section through body portion **64** in the described embodiment will yield a plus sign (+) or an X depending on orientation. It is contemplated that different configurations might be employed such as a rib cross-section of a Y-section and others. Also, although machining has been set forth above, the flutes may be formed differently such as by molding.

At the tail end of dart body **64** there is provided a recess **67** to provide a good flow area to the inside dimension of spring **50 44** which substantially reduces restriction in that area. The new check valve has been found to function well for its intended purpose and the TRSV as modified by the disclosure hereof will be more reliable for a longer period of working life.

Referring to FIG. **3**, arrows are provided to show flow of the injected chemical and its action on check valves **36** and **38**. As one will appreciate from this drawing, the pressurized fluid from the remote location moves into the configuration described to put pressure on head **62** of dart **58**. Upon sufficient pressure being applied to head **62**, spring **44** is compressed allowing fluid to flow past seal **60**, around head **62** and into the flutes **63** of dart **58**. This action is repeated at check valve **38** and the injected chemical is illustrated in chamber **54** and in all of the potential leak paths available to the chemical in the TRSV. Consideration should be given to the drafting method of illustrating the fluid in the cavity **54** and all the other places in this figure where that illustration method has been used. This is intended to indicate to the reader all of the leak paths of the chemical being injected.

In connection with the foregoing apparatus it is further desirable to allow for integrity testing of an umbilical leading to the safety valve. The device could be adapted to test lines other than chemical injection lines as well and so may be employed with other tools.

Referring to FIG. **5**, shoulder **28**, conduit **30** and channel **32** will be recognized in TRSV body **22** from earlier introduced figures. FIG. **5** also illustrates a line pressure tester assembly **80**. The assembly comprises a housing **82** and a cartridge **84**. A seal **86** on the outside dimension of the housing **82** cooperates with the inside dimension of bore **88** preventing leakage around the assembly **80**. Also visible in FIG. **5** are flow slots **90**, which cooperate with flow grooves **92** (different numbers of these grooves are illustrated in different drawings and are alternatives juxtaposing strength and flow area) in cartridge **84** when the assembly is "open". In the FIG. **5** view the assembly is "closed". It is maintained in this position by a retainer **94**, which in the illustrated embodiment is a shear pin extending through housing **82** and cartridge **84**. The cartridge **84** is further prevented from moving uphole by a stop **96**, which in the illustrated embodiment is a retaining ring. It will be understood that arrangements other than those illustrated for the retainer and stop are equally applicable such as but not limited to protuberances on cartridge **84** or restrictions in housing **82**. Returning to the shear pin, it will be understood that other retaining means are employable whose properties include preventing relative motion between housing **82** and cartridge **84** until a selected force is applied whereupon the cartridge is movable relative to the housing. Retainer **94** allows for resetting of the assembly **80** by replacing the shear pin. Other embodiments of retainer **94** will desirably but not necessarily be resettable. The capability of resetting allows the device to be reused while it would have to be replaced if it was not resettable.

Referring to FIGS. **6** and **7**, cross-sectional views of the assembly are illustrated to show position of the cartridge **84** in the housing **82** before and after shear, respectively. Upon exposure to these drawings one of ordinary skill in the art will immediately appreciate the relative movement between cartridge **84** and housing **82**. Upon such movement in FIG. **6**, one of the flow slots **90** can be seen. When seal **100** which is mounted on cartridge **84** and seals the cartridge **84** to the inside dimension **102** of housing **82**, moves sufficiently downstream (right in picture) seal **100** allows fluid communication between grooves **92** and slots **90** for through passage of fluid. Seal **100** is in this moved position in FIG. **6** although slots **90** do not happen to be visible in the figure. It will be appreciated that the pin is double sheared and the center portion **94'** moves downhole while the ends **94"** stay in the position they hold prior to shearing.

In operation, the assembly is subjected to a first selected pressure to verify pressure competence of the injection system using this assembly and then to a condition calculated to override retainer **94**, which may be a higher pressure.

While preferred embodiments have been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustration and not limitation.

The invention claimed is:

1. A safety valve having a safety valve housing comprising:

a hydraulic fluid pressure operated piston at the safety valve housing;

a flow tube in operable communication with the piston; and

a chemical injection configuration disposed within the safety valve housing configured to apply a chemical to an outside surface of the flow tube and the chemical

injection configuration includes a fluid conduit and a pressure test assembly for the fluid conduit, the pressure test assembly includes:

a pressure housing having at least one opening for fluid flow and fluidly connected to the fluid conduit;

at least one check valve in fluid communication with the pressure housing; and

a cartridge receivable and movably positionable within the pressure housing and located between the fluid conduit and the at least one check valve and having at least one opening for fluid flow, the cartridge being positioned to inhibit fluid communication between the fluid conduit and the at least one check valve until a pressure in the fluid conduit reaches a threshold pressure independent of a cracking pressure of the at least one check valve.

2. A safety valve as claimed in claim **1** wherein said at least one check valve comprises:

a dart having a closed head portion and a fluted body portion; and

a spring in operable communication with the dart to urge the dart into sealing communication with a seal.

3. A safety valve as claimed in claim **1** wherein said safety valve includes two check valves.

4. A safety valve as claimed in claim **1** wherein said cartridge is repositionable to inhibit said communication after creating communication.

5. A method of maintaining the operation of a safety valve comprising:

pressure testing a fluid conduit by pressurizing the fluid in the conduit, the fluid being segregated from at least one check valve;

increasing pressure in the fluid conduit above a threshold pressure of a cartridge retainer to allow fluid communication with the at least one check valve; and

injecting chemical fluid to the safety valve through the at least one check valve.

6. A method of maintaining the operation of a safety valve as claimed in claim **5** wherein said injecting includes applying pressure sufficient to unseat the at least one check valve within the safety valve.

7. A method of maintaining the operation of a safety valve as claimed in claim **5** wherein said injecting includes applying pressure sufficient to unseat at least two check valves within the safety valve.

8. A method of maintaining the operation of a safety valve as claimed in claim **5** wherein said retainer is a shear pin.

9. The safety valve as claimed in claim **1** wherein the pressure test assembly includes at least one stop to limit travel of the cartridge within the pressure housing.

10. The safety valve as claimed in claim **1** wherein the pressure test assembly includes at least one seal for sealing the cartridge to the pressure housing when the cartridge is in a position that inhibits fluid communication.

* * * * *